OPERATOR'S MANUAL

GPS *mas*TER CLOCK

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1. INTRODUCTION

Masibus' GPS masTER CLOCK has been developed to address key power and process industry timing requirements. Whether it's the monitor, control or analysis of the power system, the GPS masTER CLOCK is the cost-effective GPS time synchronization solution.

To begin with, the GPS masTER CLOCK offers superb timing accuracy (±1µs to UTC). Using GPS satellites, it generates extremely accurate output pulses and time codes in multiple formats.

The GPS masTER CLOCK synchronizes a wide variety of microprocessor-based power system equipment including: SCADA systems, remote terminal units (RTUs), protection relays, sequence of event recorders, digital fault recorders, tariff meters, Slave Display Units, Data Loggers and other Intelligent Electronic Devices (IEDs). Being a Field programmable device using HyperTerminal, a very common application in Windows, the GPS masTER CLOCK allows the user to alter the settings or choose from Time codes. The serial port COM2 (RS232) is provided for that purpose. Each output can feed directly to different areas through electrically isolated ports which ensure reliable operation in a harsh substation environment.

The GPS masTER CLOCK generates a wide range of timing signals via six output ports. The GPS masTER CLOCK is defaulted with two serial ports, a 1 PPS Port, 1 RJ-45 NTP port and four relay outputs. A fixed serial port provides NMEA 0183 $GPRMC format data. Second serial port is configurable for either NGTS or T-format. Another fixed output provides a very accurate pulse per second with accuracy of ±1µs to UTC. Optional outputs include an IRIG-B DC Level Shift, an IRIG-B Amplitude Modulated (AM) time code signals and 4 additional event outputs. Time synchronization protocol (NTP) standard as Server/Broadcast mode implemented in GPS to provide time synchronization to different slaves supporting NTP protocols.

All GPS masTER CLOCK units feature a front panel display, giving both installation teams and users visual feedback about the time data being generated on the outputs. LED indicators provide "at a glance" status information.

The optimized Receiver/Antenna system employed in the GPS masTER CLOCK provides time information from the GPS satellite constellation. Dynamic T-RAIM processing is used to eliminate any aberrant satellite signals from the timing solution. The result is timing precision on all outputs with accuracy similar to that normally seen only in laboratory instruments.

The GPS masTER CLOCK unit occupies the size of 19" x 12" x 3.5". It is supplied complete with all hardware and software required for the installation, including the Antenna, Antenna mounting kit, 10 meters Antenna cable, 3 meters RS-232 cable and 10 meters RG58 Co-axial cable.

2. SPECIFICATIONS

Fig 1: GPS masTER CLOCK

RECEIVER CHARACTERISTICS

Timing Accuracy
<2 ns in the presence of Selective Availability (SA) and tracking of 12 satellites

Positioning Accuracy
<25m SEP without SA

Receiver Input
1575.42 MHz L1 C/A Code

Tracking
12 parallel channels

Acquisition Time
Hot Start: <25 s
Warm Start: <50 s
Cold Start: < 200 s

Memory Backup
Internal 5 mAh cell
Sufficient for 2 weeks of backup time
Needs 24-36 hours run for full charging

Antenna
L1 GPS, 25 dB Gain,
RG8/58/9913 Cable
Maximum length: 100m (In noise free environment with LMR400)

FIXED OUTPUTS

Pulse
1 PPS
±1 μs Accuracy with GPS locked
TTL into 50 Ω
Rising Edge on time
Rise Time: < 15 ns
200 ms Pulse Width
Rear Panel BNC Female
Maximum Distance: 10 meters
Isolation of 2000 MΩ at 500 VDC from all other ports.

Serial
NMEA-0183-$GPRMC on COM 1
NGTS/ T-Format on COM 2
9600-8-N-1 on parameters COM1
4800/9600-7/8-N/E/O-1/2 on COM2
Isolation of 2000 MΩ at 500 VDC from all other ports.
DB9 Female Connectors
Maximum Distance of 50 mts.

OPTIONAL OUTPUTS

Event
One Event per minute or per hour
350 DC, 120mA maximum
8-Way Terminal Strip
Suitable Electric Wire: 22~14 AWG
Isolation of 2000 MΩ at 500 VDC from all other ports

Alarms

Three Isolated Dry Contacts to 230 V AC, 10 A:
1. GPS Lost
2. Watchdog
3. Power Fail

8-Way Terminal Strip
Suitable Electric Wire: 22~14 AWG

IRIGB-TTL

Serial Code with DC Level Shift
TTL into 50 Ω
Rise Time: < 15ns
Rear Panel BNC Female
Maximum Distance: 10 meters
Isolation of 2000 MΩ at 500 VDC from all other ports.

IRIGB-Modulated

1 KHz AM Signal
3:1 Modulation Ratio
0-10Vpp (Unloaded)
0-3 Vpp (50 Ω load)
Rear Panel BNC Female
150 Ω Output Impedance
Isolation of 2000 MΩ at 500 VDC from all other ports.

Ethernet Output:
Time Synchronization protocols:
NTP/SNTP Server
[Factory settable]

NTP: Network Time Protocol
(All versions compatible)
TP: RFC- 1059, RFC- 1119, RFC- 1305
SNTP: RFC- 1361
Network Protocol OSI Layer4
Transport layer: UDP
Internet protocol: IPv4
Modes: Server / Broadcast
Protocol Time format: UTC
Protocol standard: Universal
Time Output port: Rear Panel RJ-45
Network Interface: 1 x 10Mbps
Isolation of 2000 MΩ at 500 VDC from all other ports.

Additional Event Outputs

Four independent configurable Event outputs
Individual configurable time period and pulse ON time through COM2
Time Period: 1 to 86400 seconds (24 Hr.) max
ON Time: min. 200 milliseconds and max 50% of period time set for particular event
Event contact capacity: 350 DC, 120mA maximum
Isolation: 2000 MΩ at 500 VDC from all other ports.

INTERFACE

Display

99x24 mm, 2x16 LCD with Backlit

Displayed data

Time of Day (HH:MM:SS)
Day of week
Date (DD/MM/YY)
Latitude, Longitude, Height
Number of satellites available
Data Format on COM2
Parameters of both serial ports
GPS status information

Status LED

Power	: Red
PPS	: Red
Event	: Red
Watchdog	: Red
GPS Locked	: Green

Programming

Using HyperTerminal in a local PC via COM2
Programmable parameters:
- Global Time zone correction
- 12/24 Hrs Format of Time
- COM2 serial port setting
- COM2 data format selection (NGTS or T-FORMAT)
- Duration of Programmable repetitive event generation output via dry contact (Per Minute or Hour).
- Password Protection

Network Settings

- IP address, Subnet mask, Gateway configurable through Telnet remote login.
- All network configurations are password protected.

POWER SUPPLY

AC : 90 to 260 V, 47-440 Hz, 1φ
DC : 110-340 V
Power Consumption: 15W
Compliance: FCC-B, CISPR22-B,
EN55022-B, VCCI-B

PHYSICAL DIMENSIONS

19” Rack Mountable:
Width : 426 mm (18.35”)
Depth : 300 mm (11.84”)
Height : 2 U – 88 mm (3.46”)
Weight: 4 Kg

ENVIRONMENT

Temperature
Operating: 0° C to +45° C
Storage: -40° C to +85° C

Humidity
90% at +40° C (Non-condensing)
Conducted & Radiated Noise
Tested immunity to 10 KV
Ignition Transformer Noise

EXTRA MODULE (OPTIONAL)

RS232-to-RS485 Converter
Maximum Distance: 1.2 km
Power Requirement: 24 V DC

3. TIME SIGNAL OUTPUTS

3.1 The 1pps Signal

This is a very important timing signal. It is the TTL level pulse with a width of 200ms isolated output coming from the GPS receiver. This 1pps is connected to the BNC connector on the rear panel.

3.2 The Event Signal

The signal is an isolated event output through a static relay contact. This signal is connected to two of the terminal of the 8 way barrier strip on the rear panel of the device the event is assigned as isolated event; the frequency for this event can be configured as 1 minute or 1 hour. The pulse width of the event is 1 second.

3.3 The IRIG-B Signal

The IRIG-B format is a serial format based on a message frame per second which is Co-ordinated with the synchronized 1pps time output pulse. There are two alternative forms of output, a dc level shift output, and a modulated output. The modulation frequency is 1 KHz.

For each form of output there are three output codes:-
a. A Reference Mark
b. A logical 1

c. A logical 0

For IRIG-B, each one of these codes is 10 ms long, which is 10 cycles for the modulated format. There are 100 possible codes per time frame, although not all of them are used. The code sequence is shown in Table 1, and the waveforms shown in Figure 2. The day number starts at 1 on the first of January.

The output voltage of the modulated waveform is 3 V peak to peak into a 50 ohms load. The dc level output is TTL standard and the rising edge of the pulse is "On Time". 1 kHz modulated IRIG-B signal is connected to BNC on the rear panel of the device. IRIG-B TTL level signal is connected to a BNC connector on the rear panel of the device.

Position	Type	Item	Digit	Position	Type	Item	Digit
0	Reference Mark			27 to 28	Logical 0		
1	Signal	Seconds	1	29	Reference Mark		
2	Signal	Seconds	2	30	Signal	Day	1
3	Signal	Seconds	4	31	Signal	Day	2
4	Signal	Seconds	8	32	Signal	Day	4
5	Logical 0			33	Signal	Day	8
6	Signal	Seconds	10	34	Logical 0		
7	Signal	Seconds	20	35	Signal	Day	10
8	Signal	Seconds	40	36	Signal	Day	20
9	Reference Mark			37	Signal	Day	40
10	Signal	Minutes	1	38	Signal	Day	80
11	Signal	Minutes	2	39	Reference Mark		
12	Signal	Minutes	4	40	Signal	Day	100
13	Signal	Minutes	8	41	Signal	Day	200
14	Logical 0			42 to 48	Logical 0		
15	Signal	Minutes	10	49	Reference Mark		
16	Signal	Minutes	20	50 to 58	Logical 0		
17	Signal	Minutes	40	59	Reference Mark		
18	Logical 0			60 to 68	Logical 0		
19	Reference Mark			69	Reference Mark		
20	Signal	Hours	1	70 to 78	Logical 0		
21	Signal	Hours	2	79	Reference Mark		
22	Signal	Hours	4	80 to 88	Logical 0		
23	Signal	Hours	8	89	Reference Mark		
24	Logical 0			90 to 98	Logical 0		
25	Signal	Hours	10	99	Reference Mark		
26	Signal	Hours	20				

Table 1 – IRIG B Code Sequence

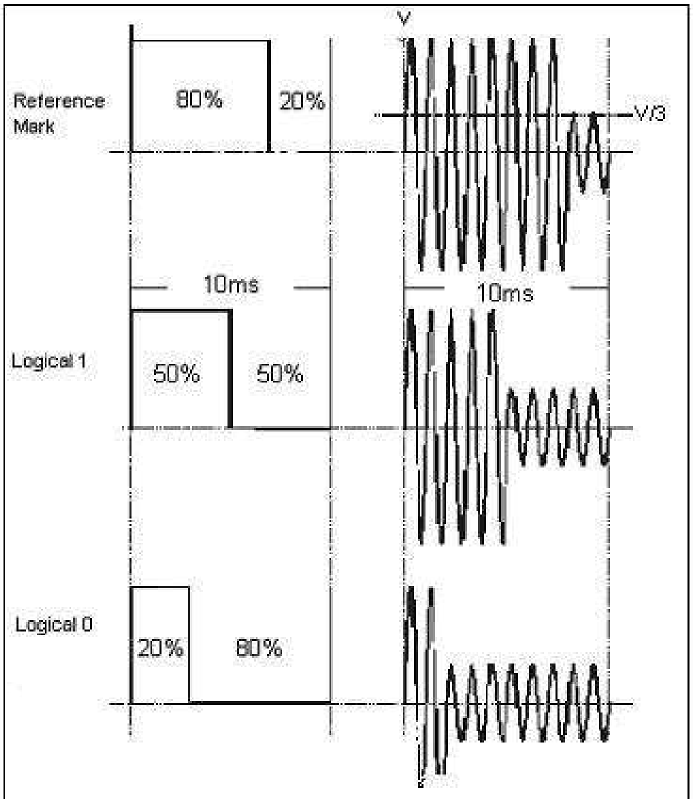


FIG : 2 - IRIG MODULATED SIGNAL

3.4 NTP / SNTP Time Protocol (Optional):

3.4.1. Introduction:

NTP(Network time protocol) is a common method for synchronization of hardware clocks in local and global networks. The software package NTP is an implementation of the actual version 3 [Mills90], based on the specification RFC-1305 from1990 (directory doc/NOTES).
Other NTP compatible Versions are NTPv1 (RFC-1059), NTPv2(RFC-1119), RFC-958.

GPS is being provided with Internal protocol based Universal time synchronization protocol i.e. SNTP (Simple Network Time Protocol) / NTP (Network Time Protocol) used to synchronize the various clocks of NTP clients to adjust with universal time. SNTP uses the standard NTP timestamp format described in RFC-1305.
Network Time Protocol is widely used to synchronize the time for Internet hosts, routers and ancillary devices to Coordinated Universal Time (UTC) as disseminated by national standards laboratories.

3.4.2. NTP:

GPS time protocol is transmitted via RJ-45 connector on UDP layer (RFC-768) at 10 Mbps provided on rear panel of GPS. GPS transmits NTP packets in various optional modes i.e. Server / Server Broadcast depending on the applications of client module. NTP packets involve the timestamp value according to UTC (Universal Time) time.

Server mode: GPS responses with current timestamp when the query is received from client.
Broadcast mode: GPS broadcasts the NTP packet at fixed intervals to clients.

Note:

a) NTP Version, Mode value in NTP packet is factory set.
b) Network **IP, Subnet Mask** and **Gateway** of GPS can be changed through Telnet. Refer document **m05/om/101-3 Appendix E** for configuring GPS master clock as Telnet Server.
c) Refer document **m05/om/101-1 Appendix C** for configuring Windows XP PC as NTP Client.
d) Refer document **m05/om/101-1 Appendix D** for configuring Unix PC as NTP Client.

```
⊟ Network Time Protocol
  ⊟ Flags: 0x1c
      00.. .... = Leap Indicator: no warning (0)
      ..01 1... = Version number: NTP Version 3 (3)
      .... .100 = Mode: server (4)
    Peer Clock Stratum: primary reference (1)
    Peer Polling Interval: 14 (16384 sec)
    Peer Clock Precision: 0.000001 sec
    Root Delay:    0.0000 sec
    Root Dispersion:    0.0000 sec
    Reference Clock ID: Global Positioning Service
    Reference Clock Update Time: Feb  7, 2036 06:28:18.2679 UTC
    Originate Time Stamp: Feb  7, 2036 06:28:18.2679 UTC
    Receive Time Stamp: Oct 15, 2009 11:33:29.3930 UTC
    Transmit Time Stamp: Oct 15, 2009 11:33:29.3930 UTC
```

Above figure shows the example of NTP packet transmitted containing different parameters.

3.4.3. NTP Packet format:

0		8	16	24	31
LI	VN	Mode	Stratum	Poll	Precision
Root Delay (32)					
Root Dispersion (32)					
Reference Identifier (32)					
Reference Timestamp (64)					
Originate Timestamp (64)					
Receive Timestamp (64)					
Transmit Timestamp (64)					

NTP Message Header

Above figure shows the NTP packet header format.

Following is the description of each parameter in NTP Packet:

leap 2-bit integer warning of an impending leap second to be inserted or deleted in the last minute of the current month, coded as follows:
0 no warning
1 last minute of the day has 61 seconds
2 last minute of the day has 59 seconds
3 alarm condition (the clock has never been synchronized)

version. 3-bit integer representing the NTP version number.

mode 3-bit integer representing the mode, with values defined as follows:
4 server

Peer clock stratum 8-bit integer representing the stratum, with values defined as follows:
0 unspecified or invalid
1 primary server (e.g., equipped with a GPS receiver)
2-255 secondary server (via NTP)

Polling interval 8-bit signed integer representing the maximum interval between successive messages.

Clock precision 8-bit signed integer representing the precision of the system clock. GPS is having clock precision of 1 us (I microseconds = 0.000001s)

Root Delay Total roundtrip delay to the reference clock, in NTP short format.

Root Dispersion Total dispersion to the reference clock, in NTP short format.

Reference clock id. 32-bit code identifying the particular server or reference clock.

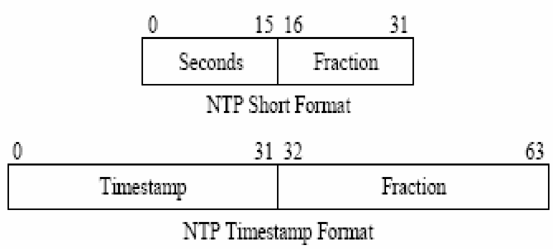
GPS Global Positioning System

Reference clock update time Time when the system clock was last set or corrected, in NTP timestamp format.

Originate timestamp Time at the client when the request departed for the server, in NTP timestamp format.

Receive timestamp Time at the server when the request arrived from the client, in NTP timestamp format.

Transmit timestamp Time at the server when the response left for the client, in NTP timestamp format.



NTP Time Formats

To configure PC as a NTP client, please refer document m05/om/101-1 Appendix C document.

OR

You can Access Procedure for configuring Windows XP using NTP server on the link http://support.microsoft.com/.

3.5 Event Outputs / BCD Time Format Output (Optional)

Event Outputs

The additional four event signals are available at the terminal strip on the rear panel of the **GPS masTER CLOCK.** User can configure these relays through COM2 for time ranging from 1 to 86400 seconds individually for separate event outputs. User can configure their Time period as well as their ON time through COM2 port.

Time Period limit: 1 to 86400 seconds
(0 values are to inhibit/stop particular event output).
ON time limit: 200 milliseconds (min.) to 50% (max.) of particular event time period. Ensure that ON time value of all additional events are to be entered in **milliseconds**.
(If time period is 0, the ON time will be also 0 by default).

Whenever the new time period is set, the new event timing counter will start from the very next minute and the contact will be energized after the settable time for that particular event. Please ensure to switch power of the instrument OFF and ON once if the event time period settings are changed.

3.6 RS232 Outputs

There are two RS232 serial ports equipped within the device. These two serial ports use two separate high performance chips to get electrical isolation. Each serial port has its own format of the timing strings. On serial port one, 9 ways D-type socket, the message is NMEA ($GPRMC) format. The serial port two, 9 way D-type plug, the message is NGTS or T-FORMAT.

3.6.1 NMEA Format

RMC RECORD FORMAT

The $GPRMC sentence contains time and date of position fix, speed and course information.The following examples show the contents of a typical RMC sentence:

The settings for this serial format is 4800, 8, N, 1.

The full data message of this format shall consist of data fields as follows:

Field	Example	Comments
Sentence ID	$GPRMC,	
UTC Time	130525.00,	hhmmss.ss,
Status	A,	A = Valid/V = Invalid,
Latitude	4250.5589,	ddmm.mmmm,
N/S Indicator	S,	N = North/S = South,
Longitude	14518.5084,	dddmm.mmmm,
E/W Indicator	E,	E = East/W = West,
Speed over ground	000.1,	Knots,

Course over ground	245.0,	Degrees,
UTC Date	291206,	DDMMYY,
Magnetic variation	,	Degrees,
Magnetic variation	,	E = East/W = West,
Checksum	*25	*CC
Terminator	<CR><LF>	Non-printing characters

Table 3: RMC Record Selection

3.6.2 NGTS Format

The settings for this format are programmable. The full data message of NGTS format shall consist of 14 printable characters and a concluding CRLF as follows:

Description	Number of Characters	Character Position	Range of Value/Information
Code Identification	1	1	Capital T
Year in Century	2	2,3	0 to 99
Month	2	4,5	1 to 12
Day of Month	2	6,7	1 to 31
Day of Week	1	8	1 to 7
Hours	2	9,10	0 to 23
Minutes	2	11,12	0 to 59
GMT Marker	1	13	0 or 1
Validity Marker	1	14	0 or 1
CRLF	2	15,16	Non-printing character

Table 4: NGTS Format

The transmission sequence shall be from the Code Identification character through to the CRLF with the most significant digits being transmitted first.

The message shall become automatically available at one second prior to the clock minute epoch.

3.6.3 T-Format

The settings for this format are programmable. The full data message of T-format shall consist of 21 printable characters with a concluding CRLF as follows:

Description	Number of Characters	Character Position	Range of Value/Information
Code Identification	1	1	Capital T
Divider	1	2	:
Year in Century	2	3,4	0 to 99
Divider	1	5	:
Month	2	6,7	1 to 12
Divider	1	8	:
Day of Month	2	9,10	1 to 31
Divider	1	11	:
Day of Week	1	12	1 to 7
Divider	1	13	:
Hours	2	14,15	0 to 23

Divider	1	16	:
Minutes	2	17,18	0 to 59
Divider	1	19	:
GMT Marker	1	20	0 or 1
Validity Marker	1	21	0 or 1
CRLF	2	22,23	Non printing character

Table 5: T- Format

4. INSTALLATION

4.1 Packing List

Each GPS masTER CLOCK is shipped with the following:

- GPS masTER CLOCK, Model MC-I time source with Regular outputs
- User Manual (This Document)
- Timing 3000 GPS antenna
- Antenna Mounting Kit
- 10 meters LMR- 195 Antenna Cable with N-to-BNC connectors
- 19” Rack mounting plate and fasteners
- 3 meters RS-232 Interface cable (Male to Female)
- 10 meters RG-58 Co-axial cable with BNC Male Connectors
- masTER SYNC Software for PC Synchronization

4.2 Mounting the Unit

The GPS masTER CLOCK is designed to be mounted in a 19 inch rack, but may be used on a bench. The unit is attached with to the rack mount via four screws in the four corners of the front panel.

The device should be installed inside a control room or suitable place without directly effected by the changing of the condition of the weather. The environment temperature should meet the requirement of the device.

4.3 Mounting the Antenna

The Antenna should be located in a position with as clear a view of the sky as possible, over as wide an angle as possible. An absolute minimum is for it to have a view of 90% of the sky. It should be mounted at least 0.5m clear of near by walls or other objects.

The antenna should also be mounted in a “Lightning-protected zone”, as far as is possible. In practice, this means ensuring that there is at least one other ground-bonded structure located in the same rooftop area (e.g. lightning rod) that reaches significantly higher than the top of the GPS antenna. The GPS antenna should be mounted so that it lies within a 45-degree angle “skirt” from the top of the other ground-bonded structure. The GPS antenna mount itself should also be securely bonded directly to the building protection ground – and not connected via any other grounded structures.

The mounting kit can be fastened to wall or fitted to the pipe using the screws supplied. The antenna should be first placed through the hole of the mounting kit and then the antenna cable should be fitted. The antenna erection at right angle wrt the ground is a must.

4.4 Antenna Cable

The cable used must be with sufficient shielding. If the shielding is not sufficient, the cable should not be in close proximity to power or other RF cables carrying transmitter signals- in particular, parallel runs are to be avoided if possible. If such runs are absolutely unavoidable, a minimum separation of 30 cm may be used as a guideline.

The GPS receiver embedded in the GPS masTER CLOCK has excellent OOB rejection characteristics, as does the antenna itself. However, sound engineering practice should not rely on these factors alone to guarantee performance. Careful installation will enhance the long-term reliability and on-going stability of the GPS masTER CLOCK.

The maximum length of the cable is 100 meters when the LMR400 or Belden 9913 cable is used. If the distance to be carried.

4.5 Suggested Assembly Order

The installation of **GPS masTER CLOCK** is very simple. Follow these steps:

- Connect GPS receiver antenna. The antenna should be at sufficient height and in open surrounding, with no obstacles nearby. Please follow the above stated guidelines.
- Make sure your power supply is in compliance with the specification and then connect power supply.
- Make the connections between time signal outputs and corresponding devices.
- Connect the alarm signals to respective devices.
- Figure 4 show the views of front panel and rear panel of the **GPS masTER CLOCK** device respectively.

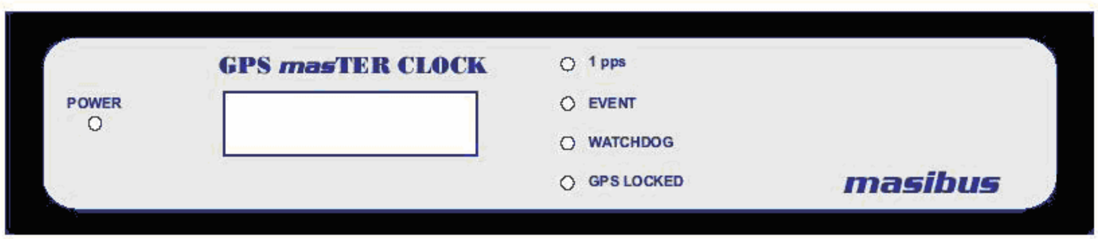


Fig 3: Front Plate

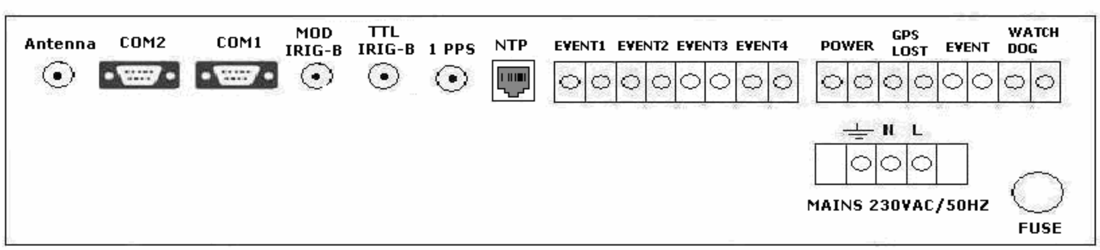


Fig 4: Rear Plate with Event Outputs

- On the front panel of the device, there is a 2*16 characters LCD display.
- There are five LEDs. These LEDs indicate the status of the device.
  - LED 'POWER' is the indicator for power supply.

  - LED 'GPS LOCKED' is the indicator for GPS locked. LED 'EVENT' is the indicator for event output.
  - LED '1 pps' is the indicator for one pulse per second output.
  - LED 'WATCHDOG' will be lit only when the application program has been stopped for some reason.
- All wiring connections are located on the rear panel of the device. Power supply connector and one power supply fuse is also present at the rear panel.
  - ANTENNA is used for connection of the GPS receiver antenna.
  - COM1 is a 9 way D-type socket and the time message is NMEA ($GPRMC) format on this serial communication port.
  - COM2 is a 9 way D-type plug and the time message is standard NGTS or T-FORMAT on this serial port.
  - There are also three BNC connectors on the rear panel.
    - One with label '1PPS' is the TTL level output of one pulse per second signal.
    - One with label 'IRIG-B TTL' is the dc level shift IRIG-B signal output.
    - One with label 'IRIG-B MOD' is the modulated 1 KHz IRIG-B signal output.
  - NTP is RJ-45 female Ethernet connector provides NTP (Ethernet) output for synchronization of NTP clients with GPS.
  - Three pairs of alarm contacts are located between terminals 1 and 2, terminals 3 and 4, terminals 5 and 6 respectively. They are assigned as 'WATCHDOG', 'POWER FAIL' and 'GPS LOST' accordingly.
  - Optional output- There are 4 additional event outputs/contacts EVENT1, EVENT2, EVENT3, EVENT4 provided on GPS rear terminal each with 350 VAC @ 120mA (max) capacity.

- **On first installation after about 15 days of off-state, the instrument may initially show incorrect time because the battery of the receiver could be discharged. It is required to run the system for 24 hours continuously to completely recharge the battery and with antenna, so that it can get the correct time**.

4.6 SELF MONITORING

After the connections of power supply and GPS antenna, the device is ready to be switched on.

- As soon as power is switched on, the green LED 'POWER' will be lit.
- The LCD display will also be lit and display some message as shown in figure 5(a) to 5(d).
- The first screen of the LCD display is the name of manufacturer (Figure 5(a)). The second screen is the message for settings of two serial communication ports. The third screen is name of the device and the message 'Connecting….' will be displayed until the device locks with the GPS receiver signal. This may be as long as a few minutes.
- For the first time when the device is switched on, the exact location will not be available for 2-15 minutes after the GPS has locked. This will depend on the duration the device has been switched off and the distance the device has been moved.
- After the device is locked with satellite signals, the green LED 'GPS LOCKED' will be lit. The LCD display will restore to normal display situation. The normal display screen shown as in Figure 5(d).

4.7 AVAILABLE ALARMS

Three alarm contacts are available on the connector block. They can be used to indicate operation of the instrument to any remote device. The alarm contacts are all dry contacts with ratings as detailed in the specification. They are all in open positions when the system is working correctly, and closed in the event of a failure.

The events covered are:

(a) No power to the instrument
(b) Watchdog failure (i.e. firmware problem)
(c) GPS not locked.

Alarm (a) can be checked by switching the instrument off and checking that the contact closes. Alarm (b) cannot be checked on site, and alarm (c) should give an alarm when the instrument is first switched on before the clock synchronizes.

MASIBUS AUTO. & INSTR. PVT. LTD.

Figure 5.a

COM 1: 9600 - N - 8 - 1 COM 2: 9600 - N - 8 - 1

Figure 5.b

GPS masTER CLOCK CONNECTING.........

Figure 5.c

TIME: 12 : 00 : 00 DATE: 01 / 01 / 07

Figure 5.d

Figure – 5

4.8 TIME OUTPUT PORTS

A wide range of time related output signals are available from this instrument to suit a wide range of possible applications. To complete installation of the instrument all that remains is to couple the required outputs to the associated equipment, taking due account of permitted signal output levels as detailed in the specification section.

The following is a summary of the signals available from the various terminals, and sockets.

Connector	Signal	Description
9 pin D type COM1	RS-232	NMEA format message Pin 2: Serial Receive Pin 3: Serial Transmit (NMEA Output) Pin 4: 1 PPS Pin 5: Ground
9 pin D type COM2	RS-232	Standard NGTS or T-FORMAT message Input – Local PC configuration COM2 can be programmed to give different output formats if required. Pin 2: Serial Receive Pin 3: Serial Transmit (NGTS/T-Format Output) Pin 4: 1 PPS (for T-Format)/ 1 PPM (for NGTS) Pin 5: Ground
Terminal strip	Event	Programmable output (Assigned as isolated event), it is an isolated event through a static relay, this event is indicated by the 'EVENT' LED.
	WATCHDOG	Alarm output when firmware is not working properly.
	POWER	Alarm output when there is a power failure.
	GPS LOCK	Alarm output when there is a GPS sync loss.
Terminal Strip-2	Event - 1	Additional Programmable output
	Event - 2	Additional Programmable output
	Event - 3	Additional Programmable output
	Event – 4	Additional Programmable output
BNC	TTL Pulse	1pps signal
BNC	AM Signal	1 kHz IRIG B Modulated Signal
BNC	TTL String	IRIG B DC Shift Signal
RJ-45	Ethernet	SNTP Output/NTP Output

Table 6: Available Time Outputs

5. CONNECTION DIAGRAM

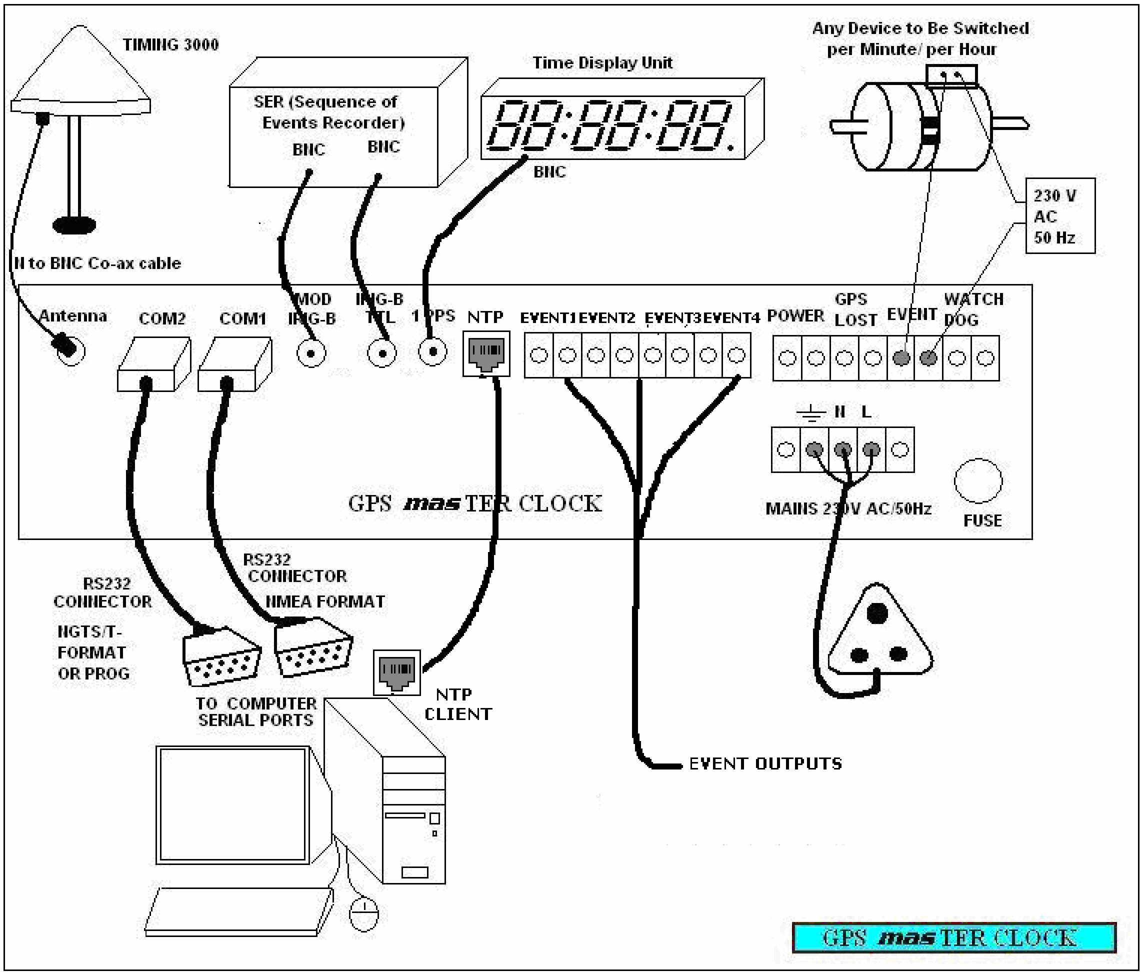


Fig 6: Connection Diagram with additional Event Outputs

6. USER CONFIGURATIONS

GPS masTER CLOCK offers facility to the users for configuring communication parameters of serial port COM2, Time format Option of COM2, Display Format on LCD as well as Event Mode.

- The communication parameters include baud rate, number of stop bits and parity.
- The user is free to choose either NGTS or T-Format on COM2.
- The LCD Display Format includes Hour Mode and Time Format (UTC/IST).
- The Event Mode can be either one event per minute or per hour.
- The user can enter the time offset of the time zone, where the unit is to be installed.
- The user can change IP address, Subnet Mask & Gateway of GPS master clock.

Configuration requires a standard 9-way D-type RS-232 cable and standard communication software in the PC, such as **HyperTerminal**. HyperTerminal is available in every Windows based PC on the link shown in figure 7.

Fig 7: Path of HyperTerminal

6.1 INITIALIZING THE CONFIGURATION

The cable requirement for the GPS masTER CLOCK configuration is shown in figure 8.

Connect one end of the cross cable to the COM2 of the **GPS masTER CLOCK** and other end to an available serial port on your local PC.

Open the **HyperTerminal** and start **new connection** on **COMx** of your PC. (x can be any available serial RS232 port number)

In using **HyperTerminal**, it is recommended to select **File\Properties\Settings** and set **Emulation to ANSI**, to avoid auto-detect making unwanted changes to the settings.

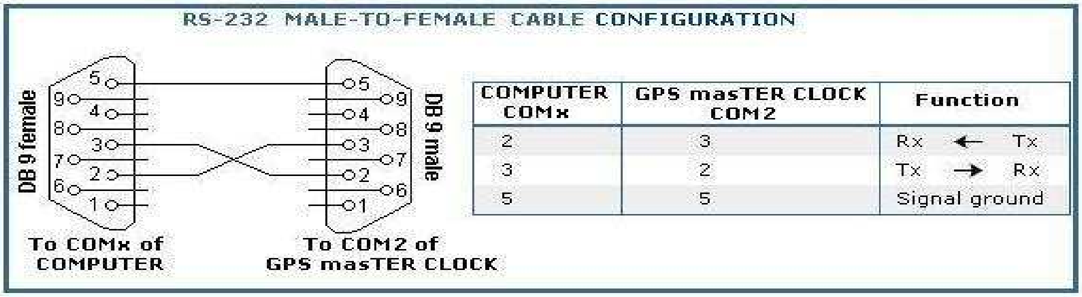


Fig 8: Cable requirement for configuration

The port settings in **HyperTerminal** and the COM2 port of the **GPS masTER CLOCK** must match each other for fruitful communication. The settings of COM2 of **GPS masTER CLOCK** are defaulted to 9600 baud, 8, N, 2 and may be checked by observing the LCD on boot up. The settings of the **HyperTerminal** must be set same as that observed on LCD to initialize the communication. This is shown in figure 9 and 10. In order to configure the settings, first disconnect (See step 2 on page 20) the communication on the **HyperTerminal**.
Once the communication parameters are set as that of **GPS masTER CLOCK**, you will get NGTS data by default on the **HyperTerminal**, as shown in figure 11.

COM 1: 9600 - N - 8 - 1
COM 2: 9600 - N - 8 - 1

Fig 9: COM port Settings of GPS masTER CLOCK

Fig 10: Configuration of Settings of HyperTerminal

T0701022120101
T0701022120201
T0701022120301
T0701022120401

Fig 11: Default NGTS Data on HyperTerminal

This was the journey to get time format on RS-232. To configure the RS-232 communication, the user needs to follow the below listed commands.

6.2 PRECAUTIONS

1. The unit will enter the configuration as soon as it will receive CONFIG command followed by an "Enter".
2. Once the configuration mode is entered, the unit will stop sending time frames on COM2.
3. Any pressing of "Enter", if not followed by any command, will put the unit out of configuration mode and the time frames will start getting transmitted from COM2 again.
4. In case of improper entry of command, following message will appear on the screen:

INVALID COMMAND
TO SET DEFAULT CONFIGURATION PRESS 'D'
TO CONTINUE PRESS ENTER

6.3 CONFIGURATION COMMANDS & PASSWORD

CONFIG

This command lets the user to enter in the configuration mode. Once writing 'CONFIG' and pressing 'Enter' key, will stop the display of the T-format data and will ask the user to enter the password, as shown below:

T0701022120401
T0701022120501
CONFIG
ENTER PASSWORD : _

ENTER PASSWORD

There are two passwords for **GPS masTER CLOCK**. One is user-defined password, which can be changed by the user. By default, this password is '**MASIBUS**'. Another is Immortal Password that cannot be changed by any user and it kept confidential to Masibus Service Engineers. Users are asked to change the user-defined password.

Enter the correct password and press Enter. As a result, it will ask the user to enter any command to configure the parameters. This is shown below:

```
-------------------------------------------------------
ENTER PASSWORD :  *******

PASSWORD OK
ENTER COMMAND TO CONFIGURE PARAMETER.
H FOR HELP MENU.
L FOR PRESENT SETTINGS.
Z FOR TIME-ZONE SETTINGS.
_
-------------------------------------------------------
```

If the entered password is wrong, the following message will be displayed:

```
-------------------------------------------------------
ENTER PASSWORD :  ****

WRONG PASSWORD
TO CONTINUE PRESS ENTER

T0701022120501
...
-------------------------------------------------------
```

To enter into the configuration mode, again write 'CONFIG' and enter correct password.

L: LIST PRESENT CONFIGURATIONS

On writing 'L', it will display the present settings of the parameters of **GPS masTER CLOCK**.

```
----------------------------------------------------------------------------
...
H FOR HELP MENU.
L FOR PRESENT SETTINGS.
Z FOR TIME-ZONE SETTINGS.
L
                    PRESENT SETTINGS
```

COMMAND	MODE NAME	VALUE(x)	MEANING
STx	Hour Mode	2	24 Hour Mode
SBx	Baud Rate	96	9600 Baud Rate
SPx	Parity	0	Parity None
SSx	Stop Bit	1	1 Stop Bit
SUx	Time Format	1	UTC time
Tx	Transmit Mode	1	NGTS Mode
Ex	Event Mode	1	Minute Mode
ET1	Addi. Event1	00000001	Second Mode
ET2	Addi. Event2	00000001	Second Mode
ET3	Addi. Event3	00000001	Second Mode
ET4	Addi. Event4	00000001	Second Mode
EW1	Event1 ON Time	00000200	m.second Mode
EW2	Event2 ON Time	00000200	m.second Mode
EW3	Event3 ON Time	00000200	m.second Mode
EW4	Event4 ON Time	00000200	m.second Mode

ENTER COMMAND TO CONFIGURE PARAMETER
OR PRESS ENTER TO CONTINUE.

--

H: HELP

The 'H' command will list all the commands to configure **GPS masTER CLOCK**. If the user presses the 'Enter' key before writing any command, operator has to enter 'CONFIG' and password again. Any pressing of 'Enter' instead of command will result in a jump out of the configuration mode.

H command will show the various possible values applicable to be entered for the particular parameter.

The HELP is displayed below:

--

...
H FOR HELP MENU.
L FOR PRESENT SETTINGS.
Z FOR TIME-ZONE SETTINGS.
H

GPS MASTER CLOCK SYSTEM
Version No: 101
UART commands:

```
          STx : Set hour mode to 12 or 24.(For Display)
            1 : set it to 12 hour mode.
            2 : set it to 24 hour mode.
         SBxx : Set baud rate.
           48 : 4800 baud rate.
           96 : 9600 baud rate.
          SPx : Set parity bit.
            0 : parity bit set to none.
            1 : parity bit set to odd.
            2 : parity bit set to even.
          SSx : Set stop bit.
            1 : stop bit set to 1.
            2 : stop bit set to 2.
          SUx : Set UTC OR IST time. (default set to 2 )
            1 : UTC time.
            2 : LOCAL time.
            H : Show help test.
           Tx : Set transmit mode.
            1 : ngts mode.
            2 : t-format mode.
           Ex : Set Event mode.
            1 : minute mode.
            2 : hour mode.
  P(password) : To change password.(max upto 9 character.)
            R : Reset the controller.
            D : Set to Default Setting.
         ETH0: Set to  Default Network Settings.
          ESC : Reset the receive buffer.
          ETx : To configure additional Events.
```

EWx : To configure additional Events ON Time.

ENTER COMMAND TO CONFIGURE PARAMETER
OR PRESS ENTER TO CONTINUE.

Note: a) Parameter *S : To save Parameters* is not used as it it reserved for future use.

6.4 COMMUNICATION COMMANDS

The communication commands change the parameters of serial communication port of the **GPS masTER CLOCK**. These include **SBxx**, **SPx** and **SSx**.

These commands first change the configuration of COM2 of the **GPS masTER CLOCK**, hence for the moment, the communication between the unit and HyperTerminal stops.

To reinitialize the communication, first **disconnect** the link, enter into the **settings** of the HyperTerminal and set it same as the present setting of **GPS masTER CLOCK**. Again **connect** the link.

SBxx

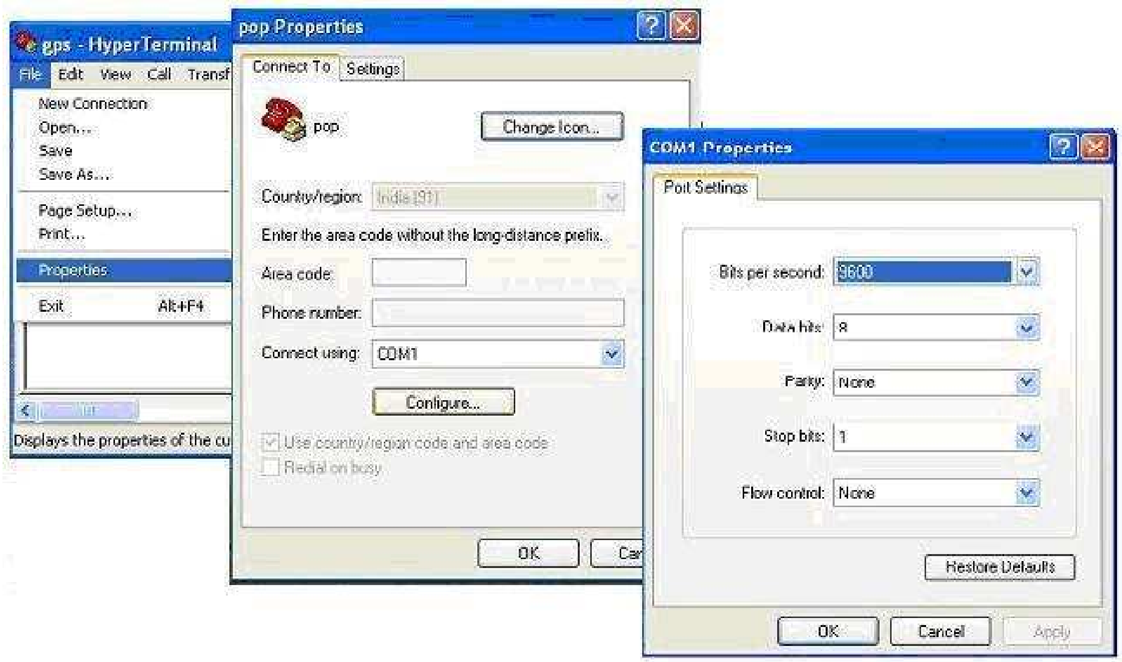
1. Suppose that the desired baud rate is 4800, the command should be **SB48** (See H: HELP). This will display following on the **HyperTerminal**:

   ENTER COMMAND TO CONFIGURE PARAMETER
   OR PRESS ENTER TO CONTINUE.
   SB48

   Now, the communication must have stopped.

2. **Disconnect** the link by a right click on **Call\disconnect**.

3. Enter the settings by following the path:
   File\Properties\Connect To\Configure.



4. Set the baud rate to 4800 and check for other parameters to be same as that of the **GPS masTER CLOCK**.

5. After setting the parameters, reconnect the link by right click on **Call\Call**.

6. Now press **ESC** and **Enter** keys.

7. Once the connection is reestablished, the time data will again be displayed on the HyperTerminal.

Now, without pressing 'Enter' anymore times, if you enter any of the commands listed in help, you do not need to reenter the 'CONFIG' and password. Press 'L' to check whether the baud rate change was accepted or not.

SPx

The change of parity configuration can be done using this command. Different options for the parity settings are as below:

SP0: No Parity
8 data bits
SP1: Odd Parity
7 data bits
SP2: Even Parity
7 data bits

Same as **SBxx** command, the communication stops as soon as you finish the command and press 'Enter' once. This is because the protocol settings at **GPS masTER CLOCK** and **HyperTerminal** do not match. To correct this, follow the steps 2 and 3 of **SBxx** command. Now correct the parameter to match with desired/set ones. In this case, take care of changing the databits to 7, when the parity is either even or odd.

After setting the parity in this setting window, follow the steps 5 and 6 of the **SBxx** command. The time data will again reappear. You can check present settings using **'L'** command.

SSx

The number of stop bits in the serial communication can be set as 1 or 2 using this command. The options are simply two:

SS1: One stop bit
SS2: Two stop bits

The steps to follow are same as **SBxx** and **STx** command.

6.5 TIME ZONE OFFSET COMMAND

Z

This command is to enter the time offset of any particular location with reference to the UTC. Every country has some time zone offset in its local time wrt the UTC. The table of the time zone can be found from Internet. The following is the example of the entering a time zone.

Remember that the time zone will put its direct effect of the IRIG-B signal while it will affect the NGTS and T-frames only if the unit is set in the LOCAL TIME DISPLAY mode, using the SUx command as explained further.

Time zone offset value should be between time ranges of **-12:00 to +12:00**.
Time offset value apart from above range will be considered as INVALID command.

Z

ENTER THE TIME-ZONE OFFSET ADDED WITH THE DAY-LIGHT SAVING TIME, IF APPLICABLE.
FORMAT: (+/-)(HH):(MM)
ENTER NOW:
-02:00

COMMAND COMPLETE
ENTER COMMAND TO CONFIGURE PARAMETER.
TO CONTINUE PRESS ENTER

6.6 LCD DISPLAY COMMANDS

The 2x16 LCD on the front panel of the **GPS masTER CLOCK** displays time as either UTC or IST and 12 Hour/24 Hour mode. The commands to set these modes are as explained below:

STx

Suppose that initially the display is in 12 hour mode. The command to change it to 24 hour mode will be **ST2**.
If the hour mode were 24 initially, then the command to convert it in 12 hour mode will be **ST1**.

SUx

This command is used to select the displayed time from UTC or Local Time. There is a predefined time zone offset of any country's Local time wrt the UTC. The selection of local time using this command will add the offset to the GMT for display on the LCD as well as in the T-format and NGTS frame. The offset is entered by the user using 'Z' command that is explained later.

The commands for selection of UTC or Local Time are:

SU1: UTC Time
SU2: LOCAL Time

6.7 COMMAND FOR SELECTION OF FORMAT ON COM2

The COM2 of **GPS masTER CLOCK** allows the time format in two different ways: NGTS format and T-format. These formats are already explained before. These commands are:

T1: NGTS mode
T2: T-format mode

Remember that T-format sends the time frame each second while the NGTS sends the time frame each minute.

6.8 EVENT COMMAND

The relayed event signal is available at the terminal strip on the rear panel of the **GPS masTER CLOCK.** This signal triggers relay either every minute or every hour based on the configuration set by the command as listed below:

E1: 1 Minute mode
E2: 1 Hour Mode

6.9 ADDITIONAL EVENT'S COMMAND

The additional four event signals are available at the terminal strip on the rear panel of the **GPS masTER CLOCK.** User can configure these relays through COM2 for time ranging from 1 to 86400 seconds individually for separate event outputs. User can configure their Time period as well as their ON time through COM2 port.

Time Period limit: 1 to 86400 seconds
(0 values are to inhibit/stop particular event output).
ON time limit: 200 milliseconds (min.) to 50% (max.) of particular event time period. Ensure that ON time value of all additional events are to be entered in **milliseconds**.
(If time period is 0, the ON time will be also 0 by default).

Whenever the new time period is set, the new event timing counter will start from the very next minute and the contact will be energized after the settable time for that particular event. Please ensure to switch power of the instrument OFF and ON once if the event time period settings are changed.

ETx

This command is used to configure Time Period of Additional Events. These Events can be configured to trigger at every second to every 86400 seconds (24 hr.). These configuration commands are listed below:

ET1: Additional Event1
ET2: Additional Event2
ET3: Additional Event3
ET4: Additional Event4

EWx

This command is used to configure ON Time of Additional Events. These Events can be configured to stay ON for a minimum 200 millisecond to 50% of its period. These configuration commands are listed below:

EW1: Event1 ON Time
EW2: Event2 ON Time
EW3: Event3 ON Time
EW4: Event4 ON Time

NOTE: a) Please ensure that the instrument should be power switch OFF/ON after changing the event time settings.

6.10 COMMAND to set default IP address,Subnet mask & Gateway.

ETH0

This command is used to set default network settings of GPS masTER CLOCK.
Default network settings are,
IP Address : 192.168.100.153
Subnet Mask : 255.255.255.0
Gateway : 192.168.100.1

6.11 PASSWORD COMMAND

The user is allowed to change one password. The command for changing password is:
P (password)
The default password is 'MASIBUS'. Suppose, user wishes to change it to 'INDIA', then the command will be:
PINDIA

Remember that the password should not exceed 9 characters. If you try to keep a password that has more than 9 characters, the system will show an error "Invalid Command" and the previous password will be retained.

The Immortal Password 'LAMBDA' cannot be changed.

6.12 MISCELLANEOUS COMMANDS

Other available commands are as follows:

D

To set the parameters to default state, i.e. 9600-8-N-1. When you try to enter in the default condition from some other condition, the communication parameters of the HyperTerminal and **GPS masTER CLOCK** differ temporarily. Hence, the communication stops for a while.

To restart the configuration, follow steps 2 and 3 of the SBxx and now set the parameters of the HyperTerminal same as the default condition of the **GPS masTER CLOCK.** Now follow steps 6 and 7 of the SBxx.

R

This command will reset the **GPS masTER CLOCK.**

ESC

To Reset the receive buffer. This will erase all the data written in the buffer.

6.13 EXAMPLE

Suppose that the initial LCD conditions are 12 Hour mode UTC. Event is in 1 Minute mode. The format available on COM2 is by default T-format.

The configuration steps to display time in **24 Hour** mode **UTC**, trigger the event at **per hour** rate, to change COM2 format to NGTS, to set the time zone of India, and to set the password to **INDIA** are explained below. The Local time of India is set 5 Hours and 30 Minutes ahead of the UTC.

H command can be used to view other parameters applicable values.

```
...
CONFIG

ENTER PASSWORD :  *******

PASSWORD OK
ENTER COMMAND TO CONFIGURE PARAMETER.
H FOR HELP MENU.
L FOR PRESENT SETTINGS.
Z FOR TIME-ZONE SETTINGS.
L
                         PRESENT SETTINGS
```

COMMAND	MODE NAME	VALUE(x)	MEANING
STx	Hour Mode	2	24 Hour Mode
SBx	Baud Rate	96	9600 Baud Rate
SPx	Parity	0	Parity None
SSx	Stop Bit	1	1 Stop Bit

SUx	**Time Format**	**1**	**UTC time**
Tx	**Transmit Mode**	**1**	**NGTS Mode**
Ex	**Event Mode**	**1**	**Minute Mode**
ET1	**Addi. Event1**	**00000001**	**Second Mode**
ET2	**Addi. Event2**	**00000001**	**Second Mode**
ET3	**Addi. Event3**	**00000001**	**Second Mode**
ET4	**Addi. Event4**	**00000001**	**Second Mode**
EW1	**Event1 ON Time**	**00000200**	**m.second Mode**
EW2	**Event2 ON Time**	**00000200**	**m.second Mode**
EW3	**Event3 ON Time**	**00000200**	**m.second Mode**
EW4	**Event4 ON Time**	**00000200**	**m.second Mode**

ENTER COMMAND TO CONFIGURE PARAMETER
OR PRESS ENTER TO CONTINUE.
Z

ENTER THE TIME-ZONE OFFSET ADDED WITH THE DAY-LIGHT SAVING TIME, IF APPLICABLE.
FORMAT: (+/-)(HH):(MM)
ENTER NOW:
+05:30
COMMAND COMPLETE
ENTER COMMAND TO CONFIGURE PARAMETER.
TO CONTINUE PRESS ENTERST2

COMMAND COMPLETE
ENTER COMMAND TO CONFIGURE PARAMETER.
TO CONTINUE PRESS ENTER
SU2

COMMAND COMPLETE
ENTER COMMAND TO CONFIGURE PARAMETER.
TO CONTINUE PRESS ENTER

T1
COMMAND COMPLETE
ENTER COMMAND TO CONFIGURE PARAMETER.
TO CONTINUE PRESS ENTER
E2

COMMAND COMPLETE
ENTER COMMAND TO CONFIGURE PARAMETER.
TO CONTINUE PRESS ENTER
PINDIA

COMMAND COMPLETE
ENTER COMMAND TO CONFIGURE PARAMETER.
TO CONTINUE PRESS ENTER

ET1

Event-1 Configuration
Please enter interval (Min. = 1 sec, Max. = 86400 sec):2

COMMAND COMPLETE
ENTER COMMAND TO CONFIGURE PARAMETER.

TO CONTINUE PRESS ENTER

EW1

Event-1 ON Time Configuration
Please enter interval (Min. = 200 m.sec, Max. = 50% Of Interval):1000

COMMAND COMPLETE
ENTER COMMAND TO CONFIGURE PARAMETER.
TO CONTINUE PRESS ENTER

L

PRESENT SETTINGS

COMMAND	MODE NAME	VALUE(x)	MEANING
STx	Hour Mode	2	24 Hour Mode
SBx	Baud Rate	96	9600 Baud Rate
SPx	Parity	0	Parity None
SSx	Stop Bit	1	1 Stop Bit
SUx	Time Format	1	UTC time
Tx	Transmit Mode	1	NGTS Mode
Ex	Event Mode	2	Minute Mode
ET1	Addi. Event1	00000002	Second Mode
ET2	Addi. Event2	00000001	Second Mode
ET3	Addi. Event3	00000001	Second Mode
ET4	Addi. Event4	00000001	Second Mode
EW1	Event1 ON Time	00001000	m.second Mode
EW2	Event2 ON Time	00000200	m.second Mode
EW3	Event3 ON Time	00000200	m.second Mode
EW4	Event4 ON Time	00000200	m.second Mode

ENTER COMMAND TO CONFIGURE PARAMETER
OR PRESS ENTER TO CONTINUE.

APPENDICES

THE GLOBAL POSITIONING SYSTEM (GPS)

Need of Accurate Time

Most days as we go about our business we look at our watches ten or more times in order to check "The Time". Our measurement of time has two components, the unit (the second), by which we specify the duration of events, and the reference point which enables us to use time in a general way. For example Greenwich Mean Time (GMT) is based on observations of the transit of the sun in the sky at midday at Greenwich.

Scientists need a much more accurate method of measuring, and synchronizing time than this method. This led quite early in the history of radio to the establishment of standard frequency radio transmissions, which continue to the present. Since frequency is measured in cycles/second, these transmissions automatically provide a standard for

the second as the unit of time. They also provide a time reference which is coded into the modulation of the signal. With the development of very accurate clocks based on the properties of atoms, it was found that the world did not rotate at a constant speed, and therefore atomic clocks, which depend on vibrations within atoms, were adopted as the standard, and Universal Co-ordinate Time (UTC) was established as the world standard.

In the power generation and distribution industry, synchronized time is important, although the accuracy required varies with the application. If one is trying to compare phase angles measured at different points in a transmission system without a direct connection using synchronized clocks, it is impossible to achieve the accuracy needed to be around 50 μs (for 1 degree accuracy) in the measurement.

To use synchronized clocks for fault location using traveling wave methods one needs to get 1 μs accuracy. Till now, last two higher accuracies have been very difficult to obtain, but they can now be obtained quite easily by making use of the Global Positioning System (GPS). This has the advantage of being available world wide, and does not suffer from the signal propagation problems associated with terrestrial standard radio frequency transmissions.

Introduction to GPS

The Global Positioning System was developed by the United States Department of Defense, with the object of making it possible (with suitable equipment) to find the position of a receiver in terms of latitude, longitude, and height with a high degree of accuracy. A system which can do this provides a universal means of aerial navigation.

The principle is very simple, although the implementation uses a great deal of modern technology. If one considers Figure 1 which shows a flat plane. X and Y are two known fixed points on the plane. P is an unknown point. If the distances PX and PY can be measured, then the position of point P can be calculated. Actually there is an ambiguity in that point P’ would also fit the measurements. This can be resolved if the position of a third fixed point Z is known since PZ is different to P’Z. This can be summed up by saying that the unknown point P lies at the intersection of three circles based on the known points X, Y and Z.

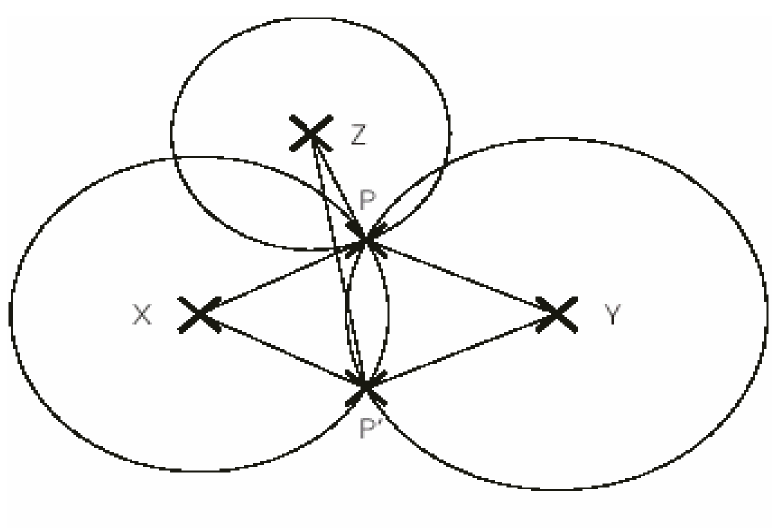


Figure 1 - The Basis of GPS

When the plane becomes three dimensional spaces, the circles become spheres. The intersection of two sphere is a circle, and the intersection of three spheres is a pair of points analogous to the points P and P' of the flat plane case. As for the flat plane case a measurement from an extra fixed point is required to absolutely resolve the ambiguity, although in many cases the ambiguous point would be below the surface of the world. Thus to achieve the objective, GPS must provide accurate measurement of distance from the unknown location of the receiver to 4 known points.
Electromagnetic radiation travels at a constant speed of approximately 300 m/μs, so if one could measure the time for radio waves to travel to the unknown point from four known points then one could calculate the position of the unknown point. This relaxation makes the GPS system practical. The "fixed points" consist of an array of 24 satellites, each of which are at a height of 20,183 km (10,899 nautical miles) and orbit the earth every twelve hours. They are distributed between 6 orbits, which are evenly spaced around the equator, and inclined at 55° to it. This means that a minimum number of the satellites are always in view from any point in or over the world.

The complete system consists of 3 parts:

A. **A Master Control Station**
   This is at Colorado Springs in America, and receives information on the status, clock data and position of the satellites from 5 Monitoring stations, which are spread around the World. It transmits control data to the satellites, via 3 up-link stations, which are again spread around the world. This data is used to correct the satellite clocks and to update their data on the orbits of all the satellites.

B. **The Satellites**
   The satellites, each has 4 atomic clocks, are kept in synchronism with UTC via the Up-links by the Master Control Station. They transmit navigational signals, which include the identity of, system time, and the almanac of satellite orbits. The transmission frequency is about 1.5 GHz, which means that signals are not affected by weather.

C. **The User's Receiver**
   This must be able to simultaneously receive signals from at least 4 satellites. Commercial receivers such as the **GPS masTER CLOCK** can deal with up to 12 signals. The receiver will process the 4 strongest signals and from them it calculates the distances to the 4 satellites, and hence the position of the receiver, and the correction necessary to its local clock to bring it into synchronism with UTC.

The system is available for free. All the user needs to do is provide himself with a suitable aerial and receiver. Navigational user's main interest is in the positional information, but as a consequence of being able to get this data, a local clock is available which is synchronized with UTC to an accuracy of ±1 μs. The **GPS masTER CLOCK** combines a GPS receiver with a microcomputer and buffers to provide a local time source with a variety of outputs suitable for synchronizing a wide variety of equipment.

A. APPLICABILITY OF GPS MASTER CLOCK

The **GPS Master Clock** can be used wherever there is a requirement to accurately synchronize equipment.

Typical applications include:

I. Digital Fault Recorders (DFR)
II. Sequence of Event Recorders (SER)
III. Supervisory Control and Data Acquisition Systems (SCADA)

IV. Power Line Fault Detection using Time Domain Reflectometer.
V. Integrated Alarm Management Systems

B. HEALTH & SAFETY STATEMENT

This product is checked and supplied in accordance with our published specifications and used in normal or prescribed applications and within the parameters set for mechanical and electrical performance. The product will not cause danger or hazard to health or safety, provided that normal engineering and safety practices are observed and the product is only used by trained and qualified persons.

All usage of this product must be in accordance with this manual. If there is any doubt about any aspect relating to the correct use of the product, please contact:

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B-30 GIDC, Electronics Estate,
Gandhinagar – 382044.
Gujarat, India.

Telephone : 00-91-79-23287275
Fax : 00-91-79-23287281

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